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ORIGINAL MEMOIRS.

CONTRIBUTION TO THE SURGERY OF NEURO-FIBROMA OF THE ACOUSTIC NERVE.¹

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WITH REMARKS ON THE SURGICAL PROCEDURE.

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THE rapid advances made during recent years in our knowledge of the location of functions in the cerebral cortex and the function and course of various conduction paths within the brain have rendered possible the localization of a large number of brain tumors.

In some instances, especially when situated in the Rolandic area or at the base of the brain implicating cranial nerves, the location of the neoplasm may be indicated with great exactness; more often, however, only an approximate idea of its situation is possible.

An estimation of the size and character of the growth is nearly always a mere matter of speculation, based on tumor

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statistics, the rapidity of the clinical course, or associated constitutional conditions.

In tumors situated near the surface of the brain, a differentiation into cortical, subcortical, or supracortical is uncertain and often impossible. So that in the present state of our knowledge an operation for the relief of brain tumor when not palliative is essentially exploratory in nature.

The most encouraging results and brilliant successes attend the removal of cortical growths, especially those which do not infiltrate the brain substance and are easily enucleated.

So that, generally speaking, any group of tumors in which the localization, nature, approximate size, and enucleability could be asserted before operation, would be especially distinguished as favorable for surgical interference.

We believe that the class of tumors under consideration, the so-called acoustic neuroma, constitutes such a group, and therefore possesses surgical possibilities and importance.

The deep situation of the growth in the triangular space at the base of the brain, formed by the junction of the cerebellum, medulla, and pons, however, presents a serious obstacle, and renders any operative procedure difficult and dangerous.

The pathology, symptomatology, and diagnosis of these tumors have been discussed at length in a previous communication by the writers. (Tumors of the Ponto-medullo-cerebellar Space, *Medical Record*, December 26, 1903.)

In the present study, the surgical aspect will receive more especial consideration.

The acoustic neurofibroma is a firm nodular growth (a neurofibroma) springing from the acoustic nerve as it emerges from the junction of the pons and the medulla. Hence the initial and most important symptom is referable to a disturbed function of the auditory nerve. (Tinnitus aurium, Ménière's syndrome, and deafness.)

The proliferation of a neurofibroma is slow, and the conductivity of the nerve-fibres is maintained for a considerable time.

The anatomical features of the location of the tumor, a preformed excavation as it were, offer some possible explanation of the periods of latency observed.

At this stage a neoplasm of the auditory nerve might be suspected; a certain diagnosis would be impossible.

With the gradual proliferation and increase in size of the tumor, adjacent structures are pressed upon, and symptoms due to compression of the pons, medulla, cerebellum, and adjacent cranial nerves are added to the clinical picture. The general symptoms of brain tumor also become manifest.

At this stage the recognition of these tumors is possible.

The symptoms may be conveniently arranged in three groups:

1. General. Headache, vertigo, vomiting, optic neuritis, bradycardia.

2. Focal. Peduncular ataxia, cerebellar ataxia, lateropulsion, hemi-asymmetry, homolateral and crossed paralyses of the extremities, paralysis of the basilar cranial nerves, especially the seventh, sixth, and fifth, dysarthria, dysphagia, nystagmus, paralysis of the conjoint movements of the eyes, inequality of the pupils, and attacks of Adams-Stokes syndrome.

3. Special. Serious impairment of the function of the auditory nerve of long standing and gradual onset.

Other pathological conditions in the posterior fossa of the skull might simulate this condition; but the initial auditory nerve symptoms, and the very gradual evolution of the clinical picture produced by a proliferation in the cerebellopontile angle, should render differentiation possible.

These tumors vary in size from a cherry to a bantam's egg. They are of fibrous structure, enveloped in a smooth capsule and present a nodular surface. They are loosely attached to the surface of the base of the brain by the leptomeninges, blood-vessels, atrophic nerve-trunks, and a few adhesions. So that enucleation is readily performed, leaving a smooth depression. Occasionally nodulations and thicken-

ings are said to extend along the auditory nerve to the internal auditory meatus. Rarely the acoustic tumor is bilateral, and other cranial nerves may be affected.

Regressive metamorphoses, hæmorrhagic areas, and sarcomatous transformation may occur, although the growth is essentially a benign one.

[FROM THE PATHOLOGICAL LABORATORY, CORNELL
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CASE I, reported by Dr. Hunt.—The patient was admitted to Bellevue Hospital, April 23, 1903. Service of Dr. Alexander Lambert, by whose courtesy I was permitted to study and record the case.

Summary.—Onset and initial symptom six years before with tinnitus aurium and slowly progressive diminution of hearing in the left ear; two years later a tendency to stagger, occipital headaches, vertiginous seizures, and fainting spells. Up to the year previous to admission all the symptoms had gradually increased in severity. Marked disturbance of the gait and equilibrium. Deafness in the left ear. Severe occipital and frontal headaches, with vertigo. Failing vision. Symptoms on admission were cerebellar and peduncular ataxia, with a tendency to fall backward and to the left. Double optic neuritis. Lateral nystagmus. Dilated and unequal pupils. Dysarthria. Paræsthesia and objective sensory disturbances in the distribution of the left fifth nerve. Paresis of the left seventh with electrical changes. Nervous deafness in the left ear. Based on the duration and chronological relation of the symptoms, the clinical and pathological diagnosis of a neurofibroma of the left acoustic nerve was made.

Operation.—The occipital bone was trephined to the left of the median line below the lateral sinus. The opening was enlarged by the rongeur forceps in the direction of the foramen magnum. The dura mater and cerebellar hemisphere bulged into the opening and did not pulsate. The finger was passed along the inferior surface of the cerebellum to the tumor, which occupied the triangular space formed by the junction of the pons, medulla, and cerebellum. It was firm and nodular and easily detected by palpa-

tion. The growth was broken up and removed in fragments by digital manipulation. Death occurred twelve hours later from cardiac and respiratory failure.

Autopsy.—The left cerebellar hemisphere in the field of operation had suffered some laceration, but without serious hæmorrhage at the base. There was, however, a hæmorrhagic focus within the left middle peduncle of the pons, which had extended inward towards the median line and was the immediate cause of death. Histologically, the tumor was a neurofibroma.

History.—The patient was a Russian Jew, aged forty-two years, a pedler by occupation. His mother and one brother died of pulmonary tuberculosis. Six brothers and one sister are living and in good health. There is no family history of tumor or any grave mental or nervous affection. He is the father of three healthy children; no miscarriages. Habits are moderate; no venereal infection. Eight years ago he received a severe blow in the back of the head from a fist, followed by momentary unconsciousness; no apparent after effects.

When first admitted to Dr. Lambert's ward, the man had but recently been transferred from Mt. Sinai Hospital. He was very much excited and confused; could not be prevailed upon to remain in bed, but would fall out, staggering and dragging himself around the ward.

As the vision was very much impaired and he could scarcely stand, it was feared he might incur some injury, so that restraints were applied to the wrists and ankles. I saw him a few hours later. He was then crying out, jabbering in Yiddish and tugging on the restraints. On being questioned, he would cease his efforts for a moment, giving a fairly intelligible answer, but then, apparently unable to control himself, would begin to toss about again, yelling and moaning. The pupils were moderately dilated and unequal, the left wider than the right; light reactions sluggish. Speech was thick and indistinct. There was a distinct weakness of the left seventh nerve, especially marked in the upper branch. After the restraints had been removed the patient became quieter, answered a few questions, but was still very confused and irritable. He was unable to stand alone, but would plunge backward, quite unable to maintain his equilibrium. A more thorough examination was postponed until the following day.

An examination of the eye-grounds by Dr. Alexander Duane showed a double optic neuritis.

April 24, 1903. Status Præsens. Patient is quiet and rational. Complains of headaches, chiefly in the occipital region, but also in the forehead; marked vertigo. He can stand for a short period alone, but then loses his balance and falls backward and towards the left side. On attempting to walk, after taking a few steps, he plunges backward and towards the left. While the tendency to fall is always backward and usually to the left, it rarely happens that he falls towards the right side. This inclination of the body backward and towards the left was confirmed by many subsequent examinations.

The legs are held widely separated and handled awkwardly, suggesting the cerebellar gait. The left leg sometimes gives way under him; while the direction taken by the patient in walking is in a line towards the left, no spiral or turning movements were at any time observed.

The gross motor power of the extremities is well preserved, save a slight general weakness of the left arm, which is also moderately ataxic. There is no ataxia of the right arm or of the legs in the recumbent posture. The tendon jerks of the arms are normal. The knee-jerks are exaggerated, more especially the left. The Achilles jerks are active, and there is a slight, easily exhaustible pseudo-ankle clonus. There is no hypotonia. The skin reflexes are normal. No Babinsky phenomenon. There are no paræsthesias or objective sensory disturbances, save in the distribution of the left trigeminus nerve, which will be referred to later.

Percussion of the skull was negative both as to tenderness and sound. The pupils are unequal and dilated, the left wider than the right, reacting feebly to light and accommodation. A slow lateral nystagmus develops as the eyeballs approach the extreme positions. No difficulty in deglutition, phonation, or in mastication. There is a distinct dysarthria. The articulation is thick and indistinct, with a tendency to division of syllables.

Cranial Nerves. The sense of taste and smell is subjectively unimpaired. The sight is almost gone, can scarcely count fingers held in front of the eyes. Double optic neuritis. The ocular excursions are normal (three, four, and six nerves).

The motility of the muscles of mastication is normal, and there is no evident atrophy. There are, however, paræsthesias (numbness and prickling) in the distribution of the left trigeminal nerve. Over this same area sensation is impaired to touch and pain; distinct spots of analgesia are present. On electrical stimulation the difference in the sensibility of the two sides of the face is clearly marked. The corneal and conjunctival reflexes are absent on the left side, and the left half of the tongue is heavily coated in comparison with the right.

The seventh nerve is paretic on the left side and of the peripheral type. This weakness is especially noticeable in the upper branch.

Electrical. Galvanic and faradic currents applied to the trunk of the facial nerve show diminished reactions on the left side. The reaction is especially sluggish in the upper branch. Applied directly to the muscles prompt reactions are elicited, of normal character, without reversal of the poles. The muscles supplied by the upper branch, however, show a quantitative increase.

Hearing is almost lost in the left ear. A watch-tick or a low voice is not heard. The vibrations of the tuning-fork are still faintly perceptible to aerial conduction on the left side. Applied to the vertex, they are referred to the right ear, although the patient also thinks he hears them faintly on the left.

The soft palate and tongue show no abnormalities of motility and no atrophy. Pulse and respirations are normal. The examination of the internal organs was negative. Urine normal.

The condition as outlined by this examination remained practically the same up to the time of operation. Variable headaches continued from time to time, not very severe, and located chiefly in the back and front of the head; also vertigo; no vomiting. At times the gait and station showed a slight improvement, so that the length of the ward could be traversed alone; but the tendency to fall backward and towards the left side persisted.

Mentally he was quite clear, although the memory appeared slightly defective, as evidenced by conflicting statements. There was none of the dullness or apathy so common in cerebral tumors.

From the general and focal symptoms just detailed, there could be no question as to the existence of a tumor in the posterior fossa of the skull, in the neighborhood of the cerebello-pontile angle, encroaching on the neighboring cranial nerves.

The early and distinct involvement of the acoustic nerve suggested the existence of a neurofibroma of the acoustic. In the diagnosis of this condition, reliance is to be placed chiefly in the initial involvement of the auditory nerve and the chronological relation of the other symptoms.

The following facts were elicited with great care from the patient and were confirmed or corrected by the members of his family.

1. Six years ago he first noticed a diminution of hearing in the left ear. This had been preceded and was accompanied by tinnitus aurium, described as a roaring, whistling, buzzing, and sound of bells.

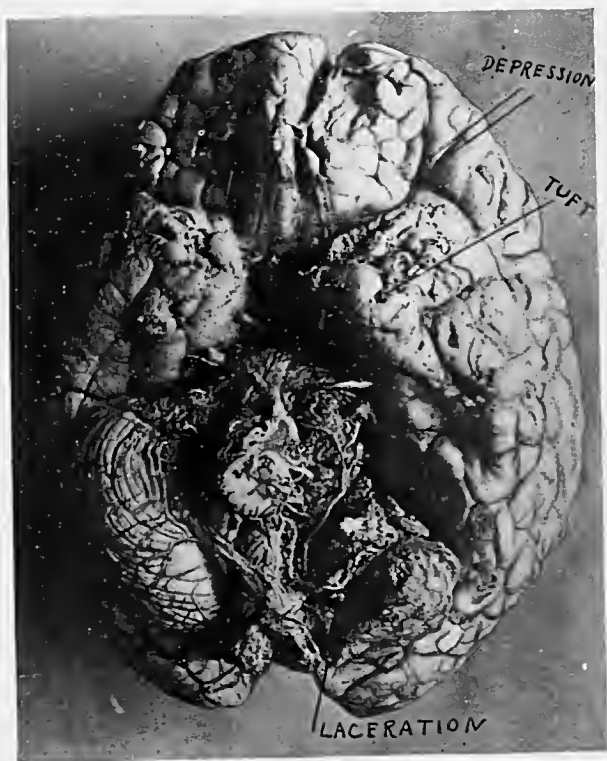
2. Two years later, in addition to the auditory symptoms, there developed a slight unsteadiness and awkwardness in the gait. The staggering at times was so pronounced as to be a source of embarrassment to the patient, giving the impression of being intoxicated. Vertiginous seizures were not uncommon, and headaches, chiefly in the occipital region, appeared about the same time. He had also occasional fainting spells with transient loss of consciousness.

3. During the last year all the above-mentioned symptoms had increased in severity. Headaches became severe and frequent with violent vertiginous seizures. The gait became staggering and uncertain and vision commenced to fail.

4. During the three months before coming under our observation locomotion had become more and more difficult, until walking or standing became an extremely precarious procedure, from the tendency to plunge backward. The dimness of vision passed into complete amaurosis.

(The paræsthesia and weakness of the left side of the face had caused the patient little or no inconvenience, and had practically escaped notice, so that the date of their appearance could not be ascertained with certainty.)

The clinical and pathological diagnosis of a neurofibroma of the left acoustic nerve was made, and the patient was transferred to the surgical ward for operation. The operation was performed, May 7, 1904, by Dr. George Woolsey. Immediately after the extirpation of the tumor, the breathing became irregular in depth and frequency, with alarmingly long intervals, and the pulse small, thready, and very rapid.



CASE 1, FIG. 1.—Site of operation showing laceration of the cerebellum. Minute tufts and depressions in the cerebral cortex.

At 5 P.M., three hours after operation, the temperature was 102° F.; pulse, 112; respirations, 26.

At 9 P.M., temperature was 102 $\frac{1}{2}$ ° F.; pulse, 160; respirations, 40.

At 11 P.M., temperature was 102° F.; pulse, 140; respirations, 36.

At 1 A.M., temperature was 101° F.; pulse, 180; respirations, 44.

Death occurred at 1.30 A.M., twelve hours after operation, from cardiac and respiratory failure. The patient not having regained consciousness. Clonic spasms of the left side of the face were noticed. No convulsions.

Autopsy and Histological Examination.—The autopsy was performed thirty-six hours after death. Permission to examine the brain only, could be obtained.

On removing the calvarium, the outer surface of the dura mater was found studded with numerous minute tufts and excrescences, resembling somewhat the Pacchionian bodies, only more numerous and more widely distributed. As the dura was turned back, many of these were found attached to the cerebral cortex and were torn away, leaving at their point of attachment minute punched-out depressions on the surface of the convolution. From the base of many of these depressions soft, fungoid-like tufts project, apparently having no connection with the dura. These minute herniæ of brain substance, varying in size from a pin's head to a split pea, were distributed chiefly over the temporal and parieto-Rolandic regions, also sparsely over the frontal and occipital lobes.

These tufts microscopically are composed of glia cells and medullated nerve-fibres, without signs of inflammatory reaction, and represent real protrusions of brain substance.

The condition is to be regarded as of teratological origin.

The leptomeninges and circle of Willis are normal.

The Site of Operation (Fig. 1).—Corresponding to the original position of the tumor, there is a depression on the left side at the junction of the pons and the medulla. Excepting this pressure distortion, the brain stem presents no external evidences of injury. The inferior surface of the left lobe of the cerebellum has been lacerated. The laceration corresponding to the region traversed by the finger during the process of enucleation. Only two small fragments of tumor tissue remain, so that the extirpation has been practically complete. A few small, insignificant blood-clots were adherent to the torn surface of the

cerebellum, otherwise the base of the brain was free from hæmorrhage.

The roots of the seventh and eighth nerves were not demonstrable, and had evidently been torn away. The left fifth nerve is flattened out and compressed. The glosso-pharyngeal-vagus groups on the left side are somewhat matted together. The other cranial nerve-roots are normal, and in none are there evidences of a neurofibromatosis.

The vermis cerebelli was incised, and the right cerebellar hemisphere removed to expose the fourth ventricle. From the left side of the floor of the fourth ventricle there rises a rounded, dark-colored swelling covered by the smooth ventricular ependyma. This tumor-like projection from the floor of the ventricle corresponds to the field of operation on the basilar surface. On incision, it proved to be a hæmorrhagic infiltration in the middle peduncle of the pons, adjacent to the laceration in the cerebellar hemisphere and extending inward towards the râphe.

The aqueduct of Sylvius was not occluded by the swelling, and there is no free blood in the ventricular cavity. The general ventricular system of the brain is moderately dilated.

Microscopical Examination.—A series of sections was prepared from the various levels of the pons and medulla oblongata, including the lacerated portion of the left cerebellar hemisphere. The configuration of both pons and medulla has been altered by the compression of the tumor, the left half showing a considerable lateral flattening. There was no atrophy of the large tracts, sensory or motor, nor of the ascending roots of the glosso-pharyngeal and trigeminus nerves.

At the level of exit of the left fifth nerve there is a fresh hæmorrhagic focus in the middle peduncle of the pons, extending inward towards the median line. This hæmorrhage is immediately adjacent to the lacerated inferior surface of the left cerebellar hemisphere, which is also the seat of hæmorrhagic foci. (Fig. 2.)

A smaller effusion of blood is also present at the level of the acoustic nerve, standing in close proximity to the glosso-pharyngeal-vagus nuclei. (Fig. 3.)

Tumor.—The fragments of tumor removed at the operation showed the original growth *in situ* to have been about the size of a bantam's egg. The growth was of a soft, fibrous consistency and

CASE I.—TRANSVERSE SECTION OF PONS.



FIG. 2.—Weigert method. Section from the level of exit of the fifth nerve. Laceration and hemorrhages of the cerebellar hemisphere. Hemorrhage in the left middle peduncle of the pons extending towards the median line.



FIG. 3.—Weigert method. Line of the glossopharyngeal nucleus, showing hemorrhage and laceration of the cerebellar hemisphere and a focus of hemorrhage below the 9th and 10th nuclei.

somewhat nodular conformation, and was easily broken up between the fingers. The surface of section is of a gray, translucent, or pearly white tint with a few hæmorrhagic foci and areas of retrograde metamorphosis.

Histologically, the neoplasm is a neurofibroma. Medullated nerve-fibres were demonstrable within the substance of the growth by the Weigert method. There are no evidences of sarcomatous transformation.

DESCRIPTION OF THE OPERATIVE PROCEDURE IN CASE I BY DR. GEORGE WOOLSEY.

At the time of operating on this case, the writer was not aware that any operation on similar cases had been reported which might serve as a guide in this case.

In this, the first operation undertaken on a tumor of this kind, correctly diagnosed and localized, the problem presented was to remove a readily enucleable tumor in the pontomedullary angle, probably not directly connected with the brain. It seemed possible to accomplish this through a posterolateral opening, as large as possible, below the lateral sinus, through which the tumor could be reached beneath the cerebellar hemisphere.

Accordingly, a large flap of skin and underlying muscles, with its base inferiorly and laterally, was turned down, exposing the lower part of the left half of the squamous portion of the occipital bone and the posterior part of the left mastoid. The occipital bone was bared very nearly to the foramen magnum. After removing a button of bone with a trephine, the opening was enlarged as rapidly as possible with rongeur. The opening was thus made to extend from a little below the lateral sinus to a point close to the foramen magnum, and from a little to the left of the occipital crest laterally until the bone became so thick that its removal was slow and difficult. This brought it close to the sigmoid sinus.

The dura was tense and showed no pulsation. On opening the dura and turning it up as a flap, the left cerebellar hemisphere bulged considerably. The forefinger inserted beneath

this hemisphere in a forward and inward direction easily made out the tumor in the position diagnosed and at a distance from the opening in the bone, easily admitting the manipulation necessary for enucleation and removal. The tumor felt nodular and hard, and could be easily distinguished from the surrounding brain tissue. Its size was greater than was expected, and it was not thought feasible at the time to remove it entire. Hence it was removed piecemeal by the finger, which was done without much difficulty. This necessitated the frequent introduction and removal of the finger, and in the removal there was the extra bulk of the fragment of the tumor held by bending the end of the finger. This necessarily resulted in some laceration of the under surface of the left cerebellar hemisphere.

In order to avoid the accumulation of a blood-clot and its infiltration into or around the brain, a large cigarette drain was introduced to the situation of the tumor, along the tract followed by the finger. There was but little bleeding during the operation. The skin flap was sutured, leaving an opening for the passage of the drain. The operation was completed within an hour and a half.

It was not thought necessary to adopt Horsley's suggestion to operate in two stages, for during the stage of approach but little blood was lost, and at its completion the patient's condition was as good as at the commencement of the operation.

During the removal of the tumor the respiration became irregular in rhythm and depth. When the patient was returned to bed after operation, this had much improved, and the pulse had responded to stimulation and was quite satisfactory. This condition continued for three or more hours, and then the patient went into collapse, which did not yield to any method of stimulation.

The autopsy showed that death was due to hæmorrhage within the left middle peduncle of the pons. The writer was convinced that this was due to the traumatism indispensable

to the frequent introduction and withdrawal of the finger, especially as in withdrawing the finger it had to be bent at the end to remove the fragments of the tumor. The enucleation and breaking up of the tumor were easily done; the traumatism was inflicted in withdrawing the finger with the tumor fragment. This traumatism could be minimized by passing a curved vulsellum along the finger and seizing the tumor, enucleating it with the finger, and then withdrawing it *en masse* after removal of the finger. That this course was not followed was owing to the size of the tumor, which was larger than expected; but in spite of this, the writer is now convinced that it could have been safely done and the fatal injury to the pons probably avoided. Some laceration of the inferior surface of the left cerebellar hemisphere was anticipated, but this laceration is unimportant, and some of this part of the cerebellum could have been excised with impunity to facilitate the extraction of the tumor. The writer is satisfied that removal of such tumors by the route employed is feasible and can be successfully accomplished, especially if the tumor is somewhat smaller.

The route followed was not directly from behind forward, but from a posterolateral opening forward and inward. From the position of this opening, the route to the pontomedullary angle is about as short as any from the cranial surface, for the opening extended very close to the foramen magnum; but of course the enucleation and removal have to be done by the sense of touch alone.

The disadvantage of the approach from a more lateral position lies in the thickness of the bone here and the longer time and greater loss of blood necessitated in making the requisite opening. This objection can be obviated in some measure by doing the operation in two stages, as undertaken in Dr. Elsberg's operation in a subsequent case.

The exposure of the tumor and the field of operation claimed for this more lateral approach are also a distinct advantage. It is an open question, however, whether this advantage exists in practice, for the increased intracranial pressure causes such a bulging in every possible direction that the con-

ditions are far different from what they are postmortem or on the cadaver.

In view of the above considerations and the definite localization and easy enucleation of such tumors, the writer is convinced that their surgical removal is feasible, and that its successful performance may be expected in a fair proportion of cases, especially if they are diagnosed and operated upon as early as possible, before they have attained a large size.

CASE II, reported by Dr. Fraenkel. *Summary.*—Male, forty-eight years old. Disease began five years ago, with progressive diminution of hearing on right side. One year later, difficulty of locomotion. Right lower extremity affected first. One year later, increase of locomotor difficulty; gait of drunken man. Transient diplopia and propulsion. Two years ago noticed the occurrence of an ankle clonus. Since two years, impairment of vision and difficulty of speech. Ataxia. Since one years, sphincteric difficulties.

On examination, static and locomotor ataxia; falls and inclines to left side; tenderness in right mastoid region; some mental apathy; stammering speech; bilateral choked disk; nystagmus; paralysis of right side of face (developed four months after admission); motor paresis and spasticity of left-sided extremities; some spasticity of right side and marked right-sided ataxia.

Preparatory operation, January 21, 1904, by Dr. C. A. Elsberg. Patient died forty-eight hours after operation.

A. G., forty-eight years old; single; theatre manager; born in United States; was admitted to the Montefiore Home, July 21, 1903.

Family History. Father died at sixty-two from Bright's disease. Mother living, seventy-eight years old. One brother died at age of seven, and imbecile; a paternal cousin died insane.

Personal History. Born naturally; was the third child; began to walk at proper time; had measles and scarlet fever. Nutrition was good in childhood; no rhachitis. Went to work as office boy at fifteen for four years. Later was a retail butcher and was in remarkably good physical condition. After six years

went on the road as theatrical manager and travelled all over the country. Always lived comfortably; had sufficient hours of rest; drank liberally of beer, whiskey, and champagne. Inveterate smoker. Gonorrhœa six years ago. Epididymitis. Syphilis denied. Bowels regular up to seven years ago, when tendency to costiveness developed.

Present Disease.—About five years ago he noticed that hearing became defective on right side; had to use left ear when telephoning. One year later gait became staggering; he had to walk on a broader basis, felt somewhat uncertain, swayed slightly. Within six months this difficulty increased markedly; the gait assumed the distinct characters of a "marche d'ivresse," so that he frequently was believed to be intoxicated. About the same time diplopia occasionally put in an appearance. One-half year later the co-ordination of the lower extremities became still worse, and was particularly annoying when he had to walk on inclined surfaces. Under such conditions he had a marked propulsion, could not stop himself, frequently ran into cars. Since about two and one-half years, patient noticed that his feet began to "beat a tattoo" when in certain positions, sometimes both feet, more often the right. Since about fourteen months is confined to bed or chair. Since about two years progressive impairment of vision; speech and handwriting are also impaired since. Pronunciation has become difficult and patient is unable to write on a given line. During this time he also noticed progressive loss of co-ordinatory power of his hands (unable to button shoes, feed himself neatly, etc.). "Cannot judge distances when reaching for articles, has lost confidence in his movements."

The patient is mentally fatigued by reading or any other effort, gave up all work since two and a half years. During the last year had frequently vesical incontinence, and could not restrain the flow when the desire came. Similar disturbances of the rectal musculature have occasionally occurred. Never had pain, paræsthesias, girdle sensation, or vomiting. Headache occasional on top or back.

Present Complaints (July 25, 1903). Patient weighs 140 pounds; of good nutrition; rather short stature; stands for a short while with feet widely apart; marked titubation; inclines and falls towards the left side; complexion is sallow and subicteric; no scars on skin, no glandular enlargement; a few pig-

mented and vascular moles; regional varicosities of veins; no other dermal abnormalities.

Circumference of head, fifty-two centimetres; brachycephalic; auscultatory percussion of skull is negative; marked tenderness in right mastoid region; slight mental hebetude, speech hesitating, syllabic.

Face. Lines well marked, innervation equal.

Eyes. Position normal; on lateral movements, horizontal nystagmus; on vertical movements and during fixation of eyeballs, rotatory nystagmus; slight clonic twitchings of right lower lid; palpebral reflex diminished; pupils equal, regular; all reactions present. No limitation of visual fields.

Ophthalmoscopic Examination by Dr. E. S. Peck.

August 5, 1903. O. D. Optic nerve can be traced under a papillitis surrounded by a complete perioptic effusion. Retinal veins are tortuous in all directions. The upper outer retinal vein is lost just outside disk, as if buried under effusion.

O. S. Condition of optic nerve same, with smaller amount of perioptic effusion.

August 8. O. D. V, $\frac{12}{100}$. O. S. V, $\frac{12}{40}$.

O. D. Peripheral V good in all directions, except above; vision above is lost down to 40.

O. S. Field of vision good in all directions, in fact, almost perfect.

O. D. Above and to temporal side of optic nerve can be counted six small spots of hæmorrhage seen through the effusion, already noted.

O. S. Three or four hæmorrhagic spots can be counted in close proximity to optic nerve.

September 9. O. D. Contour of optic nerve clearer, hæmorrhages apparently diminished.

O. S. ditto.

September 10. Examination by Dr. Karl Koller. Neuritis; optic nerve not well defined and congested (difficult in undilated pupils). Disks not well defined and retina not participating.

Ears. Normal size and shape; hearing on right side very much diminished.

Examination by Dr. Felix Cohn. Without tuning-forks, evidences of probable acoustic nerve involvement on right side. Hearing appears to be not absolutely lost.

Tongue is large, broad, not coated; protruded, straight. Sublingual veins are large and varicose. Motility of pharynx normal; uvula is long, has a beaded appearance, deviates slightly to the right side; pharyngeal reflexes very diminished. Clonic twitchings of right platysma myoides. Varicosities along the right jugular vein.

Motor functions of chest and abdomen normal; cremasteric reflexes absent; the other skin reflexes present and normal.

Upper Extremities. Volume equal and good; no deformities or atrophies. No tremors when at rest. Marked coarse, intentional tremor of upper extremities. Tendon reflexes exaggerated.

Lower Extremities. Good volume; some loss of power, more on left than on right side. Hypertonia not marked. Knee and Achilles jerks exaggerated; more marked on left. Plantar reflex; Babinsky type on left side, normal on right side. Coarse tremor of right vastus internus and gluteus maximus muscles. Sensory functions normal; some loss of deep sensibility of right upper extremity.

Thoracic and abdominal viscera normal. Pulse 72, of normal qualities; urine normal.

Decursus Morbi.—August 7, 1903. Slight frontal headache on right side; twitchings of right-sided muscles of neck.

August 18. Rectal incontinence.

August 23. Awoke with severe headache; few hours later lost consciousness; fell out of chair.

August 25. Patient is somewhat confused and wandering.

September 3. Last three days and two nights attacks of singultus.

September 27. Complains about frequent headache and increased salivation.

December 3. Attack of vertigo; loss of consciousness.

December 12. Slight transient right-sided lagophthalmus.

January 4, 1904. Mental condition slow; patient is easily confused; conjunctival and corneal reflexes of right side absent; incomplete paralysis of right seventh; marked clonic twitchings in upper and middle branches of this nerve. Deficient innervation of right half of soft palate; marked ataxia of left upper extremity; marked spastic paresis of right-sided extremities.

Examination of Sense of Taste gave the following result:

Right.	Syr. Simpl.	Chin. Sulph.	Acid Tartar.	Ol. Citr.
Anterior one-third of tongue, }	not perceived, }	salty,	acid,	lemon.
Middle one-third of tongue, }
Posterior one-third of tongue, }	sweet (delayed), }	salty,	acid,	lemon.
Left.				
Anterior one-third of tongue, }	not perceived, }	not perceived,	not perceived,	not perceived.
Middle one-third of tongue, }
Posterior one-third of tongue, }	sweet,	salty,	acid,	lemon.

Sensation of touch impaired in left anterior one-third of tongue.

Pain sensation delayed in same area.

The electrical examination showed quantitative diminution of the excitability of the right facial nerve.

January 7, 1904. Very marked tenderness of right mastoid region; marked total paralysis of right side of face; characteristics of a peripheral lesion. Occasional clonic twitchings of musculature of right side of face; marked loss of kinesthetic sensibility of left upper extremity. Abdominal and cremasteric reflexes absent on both sides.

The diagnosis of neurofibroma of the acoustic was the only one possible to reach. In view of the fact that the optic neuritis has not reached a stage incompatible with the expectation of improvement, operation was advised. Patient and his family were informed of the dangerous nature of the procedure.

Preliminary craniotomy was performed by Dr. C. A. Elsberg, January 21, 1904.

Only the first step of the operation was performed; patient died forty-eight hours after the operation, apparently in uræmic coma. The post-mortem inspection demonstrated the tumor in expected locality and of expected nature (neurofibroma). (Figs. 4 and 5.)

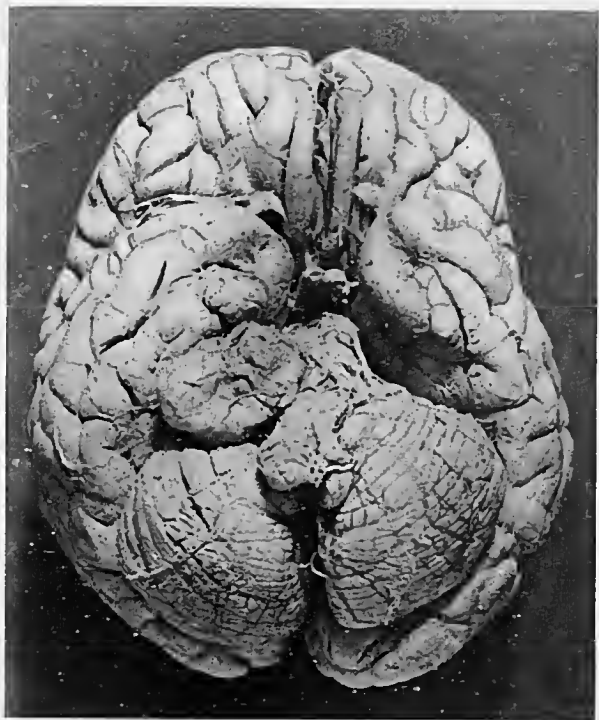


FIG. 4.—Showing tumor in situ.

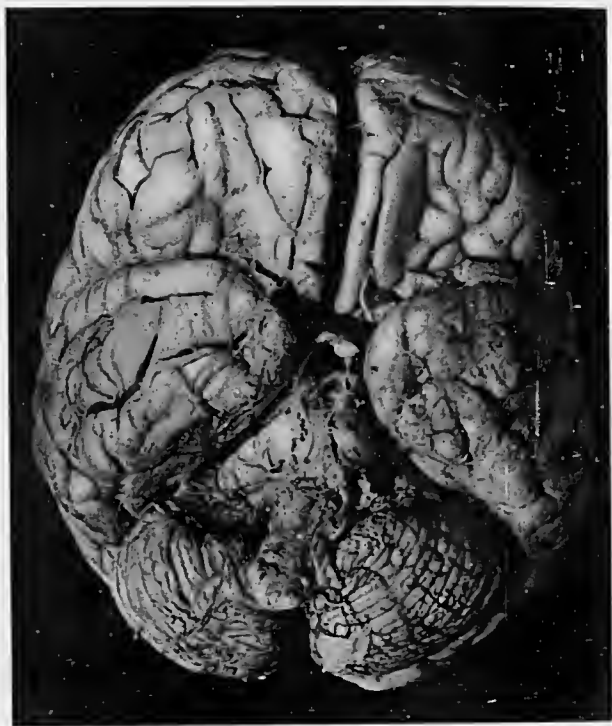


FIG. 5.—Showing depression after removal of tumor.

REMARKS ON THE OPERATION IN CASE BY DR. C. A. ELSBERG.

Incision beginning at the apex of the mastoid process on the right side, running upward to the level of the superior curved line of the occipital bone, then curving outward and then downward about four centimetres from the median line of the neck to end at the level of the beginning of the incision. This skin flap, including the periosteum, was turned down after the bleeding from the soft parts, which was quite active, had been stopped. In the middle of the area of bone thus exposed, a small button of bone about three centimetres in diameter was removed with the cranial drill, and with chisel and cranial rongeur the opening was enlarged in all directions. The lateral sinus was exposed over a distance of five centimetres in its horizontal course, as well as the entire descending loop down to the point where the sinus enters the jugular foramen. The removal of the bone occupied considerable time, as the skull was very thick. The opening in the bone measured about eight centimetres in its vertical and five centimetres in its horizontal diameter, and extended from about two centimetres above the level of the superior curved line of the occipital bone down to within one and three-fourths centimetres of the margin of the foramen magnum, and laterally from within one centimetre of the external auditory meatus outward for five centimetres to three centimetres of the median line.

In the upper part of the wound the posterior surface of the right occipital lobe covered by dura mater was visible, and in the lower part, the outer portion of the posterior surface of the right lobe of the cerebellum covered by its dura. The cerebellum bulged more than normal, and its pulsation was only very feeble.

After some oozing from the bone had been stopped with bone wax, the skin flap was turned back into place, and the entire wound closed with interrupted silk sutures, a small rubber drain having been inserted in the lowermost wound angle. A voluminous dry dressing was then applied.

Operation. Quantity of blood lost during operation (estimated), ten ounces. Condition of patient at conclusion of operation, fair; considerable shock; pulse, 120 and compressible; respirations, regular and deep.

Remarks. The patient did not stand the operative interference well, as his pulse became weak as soon as the incision in the soft parts of the scalp had been made.

The scalp was very vascular, but the bleeding was readily controlled. The hæmorrhage from the bone came from a vein in the mastoid process, but it was readily controlled and stopped with a small quantity of Horsley's bone wax.

At no time during the operation was any interference with the respiration observed.

Clinical Course after the Operation. The patient seemed to be in a condition of considerable shock when first returned to his bed. His respirations were slow and deep; his pupils contracted and equal; temperature, 100.6° F.

Within one hour of the operation, twitchings were noticed in the paralyzed facial nerve, its lowermost branches, and within two hours there was some voluntary movement in some of the branches of the nerve.

The patient was partly conscious in three hours and fully conscious in about eight hours.

During the first twenty-four hours the patient was energetically stimulated, and his general condition improved very much. He was fully conscious; did not complain of much pain; his respiration was very regular; his pulse was 120, and of fairly good quality. He had passed very little urine, however, and was therefore given subcutaneous infusions of normal saline solution at frequent intervals.

In spite of energetic treatment, his kidneys would not respond, and less than one-half ounce of urine was secreted during the following twelve hours. He gradually went into the uræmic condition, became comatose, and died on the morning of January 23, about forty-two hours after the operation.

Post-mortem Examination of the Wound. The skin flap

was turned down after the skin sutures had been divided, the wound looked clean, and there was but little secretion. The dura was incised along a line about three millimetres away from the sinus for a distance of about five centimetres, and the lateral part of the cerebellum thus exposed. Palpation with the finger at once revealed the tumor only three centimetres from the surface and lying in the posterior fossa near the apex of the petrous portion of the temporal bone. Its removal could probably have been accomplished with ease and with considerable rapidity.

The opening in the skull in our patient was made in a rather unusual situation, and it may therefore not be out of place to state briefly the reasons for the method here employed.

In most of the operations for a tumor in the posterior fossa, the cerebellum has been exposed by the so-called occipital craniotomy, in which an opening is made in the occipital bone somewhere between the median line and the posterior margin of the mastoid, and below the level of the lateral sinus. For tumors situated in front of the cerebellum, as was the tumor in our case, and for tumors in the anterior and lateral parts of the cerebellum, there are several objections to this method of exposure:

1. It is not the shortest route from the surface of the skull.

2. The manipulations in the removal of the tumor have to be done by the sense of touch alone.

3. Even with the most gentle manipulations, the cerebellum is apt to be considerably contused and its tissues injured.

4. In the digital examination of the anterior parts of the cerebellum from the under surface of the organ, the finger must come in frequent contact with the medulla and perhaps the pons; the great danger from only slight injuries to these structures is well known.

My object in investigating this subject was, if possible, to find a method by which the disadvantages above mentioned would be avoided.

As to 1. Actual measurements on a number of skulls showed that the shortest distance from the surface of the skull to the anterior edge of the lateral lobe of the cerebellum on the same side is measured on a line which runs along the posterior surface of the petrous portion of the temporal bone, and reaches the surface of the mastoid, one to two centimetres behind the external auditory meatus. The distance from the outer surface of the occipital bone below the level of the lateral sinus to the anterior edge of the cerebellum diminishes steadily as one makes measurements more and more distant from the median line. These facts show that the shortest route to the pontomedullary cerebellar space to the internal auditory opening in the mastoid process.

As to 2. If in the cadaver, an opening in the skull is made in the mastoid region and the dura incised, the lateral edge of the lateral lobe of the cerebellum falls away from the posterior surface of the petrous portion of the temporal bone, so that fully one-half of this part of the bone can be seen. With only very slight retraction, the lateral lobe can be drawn sufficiently towards the median line, so that the auditory and facial nerves can be plainly seen in their course from the pontomedullary cerebellar space to the internal auditory meatus and even the ninth, tenth, and eleventh cranial nerves can be seen in part of their course in the posterior fossa. The auditory nerve can be cut close to its origin with a fine scissors without touching the pons or medulla. I have performed the operation on the cadaver three times, and have become convinced of its feasibility. In the living body, where the cerebellum is filled with blood, the same conditions will be found, although to a somewhat less degree. This has been demonstrated by Krause, of Berlin, in a somewhat similar operation devised by him for a case in which he cut the auditory nerve in the posterior fossa for the relief of a persistent tinnitus aurium.

As to 3. As is well known, considerable of the lateral parts of the cerebellum can be cut away without causing a

permanent disturbance in the functions of this part of the brain. Therefore, this is the part of the cerebellum that can be handled with the greatest safety. As has been already mentioned, this is the part of the cerebellum that can be most easily retracted. From all of these facts, it must follow that the approach to the anterior edge of the cerebellum along its outer edge is not only the easiest, but also the route in which the organ is least apt to be injured during the necessary manipulations. Attention may again be called to the fact that with only very slight retraction of the lateral edge of the lateral lobe of the cerebellum, the greater portion of the posterior surface of the petrous portion of the temporal bone (which forms in that situation the anterior boundary of the posterior fossa) becomes visible.

As to 4. An examination into the anatomical relations of the structures in the posterior fossa will soon make it clear that when the pontomedullary cerebellar space is approached from the mastoid region along the outer edge of the lateral lobe of the cerebellum, neither finger nor instrument need come in intimate contact with the pons or medulla, until the space itself has been reached. It is probable that the correct way to remove tumors from this region is to expose the structures on the mesial side of the tumor, if possible, and to divide these first, and then to work outward all of the time away from the pons and medulla. In this way the danger of injury to these important structures is reduced to a minimum.

The writer believes that operations for tumors of the brain should always be done in two stages, and in the case here reported the first stage consisted only of the making of the necessary opening in the skull. Unfortunately, the patient succumbed to an acute suppression of urine on the third day after the operation, at a time when he appeared to have recovered from the shock of the operative interference.

GENERAL CONCLUSIONS.

1. We believe that the acoustic tumor syndrome is well defined, and that the diagnosis can be made with practical cer-

tainty. This presupposes not only the diagnosis of the location of the tumor, but its nature and comparative size. It must, however, be observed that other slowly growing pathological conditions in the posterior fossa might simulate closely this condition.

2. The slow and essentially benign nature of the growth, its non-infiltrating character and enucleability would all favor surgical interference.

3. The deep situation at the base in immediate proximity to vital centres offers *very serious obstacles*.

4. From personal observation, we believe that the surgical technique should be perfected along the following lines:

a. The avoidance of undue concussion in the removal of the bone and enlargement of trephine opening.

b. A method of extirpation by which the tumor could be extirpated without undue manipulation of the surrounding parts.

c. The division into stages, as recommended by Horsley, and celerity of execution.

5. The study of the literature of this subject is unsatisfactory because most of the cases are recorded under the heading of cerebellar tumors. We succeeded in collecting from the literature six other cases which presented the clinical and pathological characteristics of the acoustic neuroma. An abstract of these cases is appended below.

CASE I.—MCBURNIE & STARR. *American Journal of the Medical Sciences*, 1893, page 377. *Fibrosarcoma of cerebellum and pons varoli. Operation; death.* Male, aged thirty years, presented general symptoms of tumor during a period of three years. For the past year diplopia; speech slow and thick. Numbness of left side of face; tinnitus aurium.

Status.—Left external strabismus; nystagmus; choked disk; slowness of speech; hebétude and great mental apathy; progression of symptoms: optic atrophy; complete deafness in left ear with staggering gait; marked tendency to fall forward and towards right side; weakness of right hand; knee-jerk exaggerated on right side, ankle clonus on right.

Operation.—Soft parts turned back over occipital region. Opening in left occipital bone with chisel and mallet, one and a half inches in diameter; marked bulging of dura incised; protrusion of cerebellar tissue; exploration made in all directions with index-finger without locating

tumor. Considerable laceration of cerebral tissue as result of manipulation. It was impossible to replace the prolapse. Excess shaved off. Wound healed by primary intention. Aseptic throughout. Patient died December 15; temperature, 105° F.

Autopsy showed gliosarcoma; left hemisphere of cerebellum, one-half pons and one crus slightly indented by tumor; one auditory and facial and fifth implicated in tumor.

CASE II.—G. A. GIBSON. *Edinburgh Medical Journal*, 1896. A woman, aged twenty-five years. Onset ten months before admission, with headaches, giddiness, and unsteadiness in walking.

Status.—Short dagger-like pains over left eye. Vertical and horizontal nystagmus; pupils unequal, the left wider than the right. Reactions prompt. Optic neuritis.

Deafness in the right ear. Regurgitation of liquids through the nose. Voice bleating in character. On walking falls to right side. Station with closed eyes is swaying, falls to the right.

Operation by Annandale. The tumor was size of pigeon's egg and was removed piecemeal. Histologically, a fibrosarcoma. Following operation the headaches and vertigo disappeared, swallowing was perfect, and the gait was much improved; a little nystagmus persisted.

This case was reported by Dr. Purves Stewart in the *Edinburgh Hospital Reports*, 1895, Vol. iii, page 447.

CASE III.—MURRI (Bologna). *Lancet*, 1897, page 292. Boy, aged seventeen. Onset with tinnitus aurium and vertiginous seizures resembling Ménière's disease. Later, diminution of hearing on the left side progressing to complete deafness. Some tinnitus and diminution of hearing on the right side as well. Left seventh paralysis with increased galvanic irritability. Tenderness over the left side of the face on pressure (fifth). The corneal and conjunctival reflexes absent on the left. Speech thick. Rotary nystagmus; later becoming lateral. Optic neuritis, more marked on the left.

In addition has headaches, vertigo, and vomiting. The attacks, resembling Ménière's, persisted twenty months after the onset.

Marked disturbance of the equilibrium; falls backward, forward, or laterally, but not constantly in any one direction. Ataxia of left arm and leg. Tendon reflexes exaggerated, especially on the left. Has spells of unconsciousness, with transient rigidity, lasting one-half hour; also paroxysms of extreme vertigo and mental confusion, the face flushing and the pulse falling to 60.

Operation by Dr. Guido Bendanni. A portion of the tumor was removed from the neighborhood of the left half of the cerebellum. Total extirpation was impossible.

Histologically, the growth was a fibrosarcoma. One month later the boy was still alive and rather better than worse.

CASE IV.—JAFFÉ. *Deut. Med. Wach.*, 1897, No. 23, page 24. A woman, aged fifty-two years. General symptoms of brain tumor had existed for two years. Peculiar disturbance of gait; would turn towards the left side in a spiral manner. Evidences of pressure on the fifth, sixth,

seventh, and ninth cranial nerves on the right side. Acoustic not mentioned.

After trephining there was a discharge of bloody cerebrospinal fluid, the patient collapsing. The operation was not completed, and death occurred twelve hours later.

Autopsy.—On the under surface of the right cerebellar hemisphere, corresponding to the flocculus, is a polypoid-like tumor, compressing the middle peduncle of the pons. The sixth and eighth nerves are compressed and stretched by the tumor. The tumor was readily enucleable, and was so loosely attached that slight manipulation dislodged it. Microscopically, the growth was a fibrosarcoma.

CASE V.—SAENGER. *Neurol. Centralblatt*, 1899, page 117. A woman, aged forty-seven years. Duration of illness three years. Headaches, vomiting, blindness, double-choked disk. Impairment of memory. Hearing defective on the left side.

A palliative operation was performed. The trephine area was kept open for a month to allow the escape of cerebrospinal fluid. Following operation, vision improved with disappearance of the choked disks. A hemiparesis developed on the left side.

At autopsy a tumor about the size of a small potato was found in the left cerebellopontile angle, probably of acoustic origin.

CASE VI.—FRANK R. FRY (St. Louis). *Journal of Nervous and Mental Diseases*, March, 1904, page 157. Male, aged thirty-nine years. July, 1899, in Manila; tendency to go to the left; later, frequent vomiting in the morning; no nausea; twitching in fingers of right hand; some stiffness; rigidity of right face and right extremities; ataxia; tendency to move to left side; almost absolute deafness right side; throbbing in back of head; sensation normal.

Gait. Drunken stagger; inclines to left. Handwriting cramped. Ataxia of all extremities. Reflexes exaggerated, more on right side. Pupils normal. Eyes, right, 20/20; left, 20/20. Perimeter charts normal; disks showed swelling; slight hæmorrhage left at upper edge of disk. Eye-muscles worked in jerky way; tendency to nystagmus.

Locomotion became more difficult; ataxia more on right extremities, also face; writing impossible. Tendon jerks more plus on right side. The only disturbance of general sensibility was in the distribution of the right fifth nerve. Complained of unpleasant paræsthesia of right side of face and in mouth. No pain or hyperæsthesias. Mentally, no deterioration. Patient decided to try operation.

Operation by Dr. H. G. Mudd, March 25, 1902. Opening in skull about two inches in diameter. Before incision of dura, unusual resistance in pressing towards median line. After incision and careful palpation, a circumscribed firmness deep in substance of cerebellum. Cerebellum was incised; tumor plainly visible, smooth appearance, grayish tint. Operator introduced left index and with right hand a loop-end curette, grasped tumor gently and lifted it out. Attached only by frail, soft fibres, no resistance. Surrounding tissue carefully explored, nothing else found.

Size of tumor sparrow's egg, quite firm. Pronounced by Dr. Sidney Schwab a conglomerate tubercular growth.

One month after, some improvement; two months after, considerable anæsthesia of right conjunctiva. Speech and locomotion better. Better control of right arm and hand movements. Bulging at site of operation increasing in size and sensitiveness.

April 6, 1903. Patient says lump on back of head is larger, extends farther down; hand, arm, leg, right side jerky. Right ear deaf as ever; can eat only on left side; teeth coming out. Goes to work.